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THE PROBLEM OF ADAPTATION AS ILLUSTRATED BY
THE FUR SEALS OF THE PRIBILOF ISLANDS.

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(Read April 23, 1915.)

The breeding habits of the Alaskan fur seals are so unusual as to make these animals unique among mammals. During much of the year, these seals are strictly pelagic roaming over the eastern expanse of the northern Pacific as far southward as the latitude of southern California. As summer approaches, practically the whole herd consisting of several hundreds of thousands of individuals repairs to the two small islands of St. George and St. Paul in Bering Sea for the breeding season. It is the relative proportions of the various constituents of the herd during this breeding period that affords material for interesting speculation.

The movements of the fur seals in their arrival and departure from the Pribilof Islands take place with much regularity. Early in May and June the mature males or bulls, having made their way through the passes of the Aleutians, reach the breeding beaches or rookeries on the islands of St. George and St. Paul. Here they take their positions, fighting all intruders while they await the coming of the females or cows. The cows arrive on the islands chiefly during June and July. They associate themselves with particular bulls and the bull with his group of cows constitutes the family unit or harem. In 1914 the average harem was not far from one bull

to sixty cows, and the range extended from harems containing one cow to some that contained over a hundred. Because of the many years of commercial killing, chiefly directed against the males, it is impossible to state what the size of the normal average harem should be, but probably not far from one bull to thirty or forty cows.

Within a short time after the arrival of the cow, in the harem, *i. e.*, within a few days or a week or so, she gives birth to a single young or pup. So far as is known, cows do not produce more than one pup at a time. Shortly after the birth of her pup, the cow goes into heat, pairs with the bull, and becomes pregnant again. As these are annual occurrences, the period of gestation in the fur seal must be a few days less than a year. The pups are born males and females in about equal numbers. The counts of former years, as well as those of 1914, show a slight predominance of males, the excess being from a little over two per cent. to about seven per cent. of the total births.

The breeding season closes toward the end of July or early in August and this close is marked by the disintegration of the harems. During August most of the bulls begin their migrations back to the Pacific, and the pups, which heretofore have remained on the beaches, begin to take to the sea. They and the cows stay about the islands till November, when they too start on their migration to the open ocean. The only important constituent of the herd that has not yet been mentioned is the class known as the bachelors, *i. e.*, the young males that have not yet attained to breeding. The bachelors move with the cows, arriving for the most part in June and July, and departing in November, though some are found on the islands in December or even later. The bachelors do not mingle on the beaches with the rest of the herd, but gather to one side of the breeding grounds proper in the so-called bachelors hauling grounds, where they lead an idle rollicking existence suggested by their name.

The maximum age of the fur seal is believed to be about twelve to fourteen years for both males and females. In the migration, the males return to the islands approximately in the sequence of their ages; the old bulls arrive first in May and June followed by the younger bulls and bachelors and lastly by the yearling males, which arrive in the latter part of July and in August. The year-

ling males on arrival associate with the pups and cows rather than with the other bachelors. The bachelors may begin breeding at five years of age or even four, but they do not normally undertake this function until they are six or seven years old, when they desert the bachelors' hauling grounds for the breeding rookeries. The period of their normal breeding life covers, therefore, a term of perhaps some seven years or more.

It is not impossible that the yearling females do not return to the islands or, if they do, it is probable that they do so only in small numbers and late in the season. The two-year-old females return to the islands in July and August as virgin females, pair with the younger bulls, and reappear a year later, the end of their third year, with their first pup. From that time on they enter into the regular breeding of the herd and continue in all probability to produce one pup annually. Their breeding life, therefore, extends over some ten or more years.

These in brief are the main facts concerning the breeding habits of the Alaskan fur seal, an animal that exhibits one of the most remarkable examples of concentrated and localized breeding known. When it is recalled that these seals range over thousands of miles in the northern Pacific and that all sexually active members of the species without exception congregate in the appropriate season on the two small islands of St. George and St. Paul for breeding, the very exceptional nature of their reproductive activities must be evident.

The proportion of the two sexes at birth is very nearly equal, yet when the breeding age has been reached, the natural relations are not far from one male to thirty or forty females. As there is no reason to suppose that the death rate is higher in males than in females and as the length of the breeding life of the two sexes is not very different, about seven years for the bulls and about ten for the cows, it follows from the sexual proportions already mentioned, that we should expect an excess of bulls to be present. As a matter of fact, such is the case, for even in 1914, after the excessive commercial killing of males in the past, the so-called idle bulls were much in evidence. It thus appears that the Alaskan fur seal produces at birth approximately equal numbers of males and females

and yet in its breeding activities needs only relatively few males, a condition which when viewed as a whole seems to be a misadjustment rather than a close adaptation to the actual needs of the species. The measure of this misadjustment would be the proportion of idle bulls naturally present. Unfortunately, the commercial activities of the past in exploiting the herd for its fur prevent the possibility of accurate statement on this point, but the presence of idle bulls in the herd today is enough to show that this class under natural conditions would be abundantly represented.

The fur seal, however, is not the only one of the higher animals to show this misadjustment in the ratio of males to females. A prosaic example of the same kind is seen in the barn-yard fowl. Here the sexes hatch in nearly equal numbers, there being perhaps a slight predominance of females, but in maturity the cock holds sway over a flock of hens. This condition is almost exactly parallel with that of the fur seal except that it occurs under domestication. Nevertheless it has probably been inherited from the wild stock, for Finn states that though the red jungle fowl will live quite happily with a single hen, this is not universal and harems are often found. The bull of the American elk or wapiti, as my friend Dr. J. C. Phillips tells me, also forms, during the breeding season, a harem of cows from which he will drive away other bulls of his own kind, much as the fur seals do. Dr. Phillips further informs me that there are among the higher vertebrates many other instance of that particular form of polygamy in which one male during the breeding season naturally associates with many females. Such examples are found among some of the larger antelopes, wild sheep, and wild goats, and among certain birds such as the black grouse, capercaillie, and wild turkey. Although in these several species, the proportions of sexes at birth, so far as I am aware, are not definitely known, they probably follow the rule of approximate equality so common among many of the other higher animals and thus in reality illustrate much the same condition as that seen in the Alaskan fur seal.

Among the lower animals, particularly the insects, exceptional ratios in the sexes have long been known, the classic example of the honey bee being the most commonly quoted. Here a few

males, the drones, are set off against one perfect female, the queen, and a host of imperfect ones, the workers. These cases differ from those in the higher animals, however, in that the sex ratios appropriate for the breeding colony are determined from the beginning, *i. e.*, the young are not produced males and females in equal numbers. Such cases as the honey bee and other like insects exhibit, therefore, in their sex ratios much more accurate adjustments to their breeding requirements than do the higher animals; in fact they may be said to show a very high order of intracolony sex adaptation.

Throughout the animal kingdom as a whole sexual reproduction seems to be best adjusted where the sexes are represented in approximately equal numbers and this relation is probably determined by the production of equal numbers of male-determining and female-determining sexual elements. The sperm cells of most species of animals, perhaps of all, are apparently the prime factors in this determination, and the dimorphism of these cells in the sense that one class is made up of male-determiners and the other of female-determiners as well as the production of these two classes in equal numbers may be looked upon as the chief adaptation of the animal kingdom so far as sex ratios are concerned. But the reproductive activities of a limited number of animals, such as the honey bee and the fur seal, have developed in directions in which equal numbers of the two sexes serve no longer as an advantageous combination. To meet these new conditions, further adaptation would be needed and, from what has been said, this adaptation would involve readjustments in the powers of the sex-determining reproductive cells. Such readjustments seem to have been carried out in the insects as seen in the honey bee, etc., where through the development of natural parthenogenesis the usual sex ratio has been entirely set aside and a new one favorable to the new requirements has been established. This has not been accomplished by the fur seals and other higher animals which in this respect remain poorly adapted to their new relations. From this standpoint, then, such lower animals as the insects show a higher order of adaptation than either the mammals or the birds. An explanation of this paradox may be found in the fact that the rate at which generation follows generation in in-

sects is enormous compared with that in the higher animals and further that geologically speaking the insects are much older than the mammals or birds. Hence they have had a much greater opportunity to adapt themselves to their conditions than has fallen to the lot of the higher animals. If the maladjustments of the sex ratios as exhibited by the fur seals and other higher animals are to be interpreted in the way indicated, it is clear that the evolutionary processes by which adaptation is brought about must often be slow and imperfect with the result that adaptation itself is better described, in the words of Bateson, as a poor fit than in the extravagant terms of eulogy with which many of the older writers clothed it.

HARVARD UNIVERSITY,
April 23, 1915.